HVAC: Residential HVAC System Modeling

Description

This change would add hourly HVAC system models to the Residential ACM to allow Time Dependent Valuation (TDV) calculations and improve seasonal efficiency estimates. The current Residential ACM uses an hourly sensible loads model for the building envelope, but HVAC system effects are accounted for using seasonal efficiencies only. The proposed models will adapt the DOE-2 system model approach that uses a series of equations to relate the performance of the system to weather, indoor conditions, and part load. Major components of this change are:

1. Air Conditioner Model. Hourly air conditioner energy will be calculated, including the effects of outdoor dry bulb temperature and indoor humidity on the capacity and efficiency of the compressor. The effect of part load cycling on efficiency will also be included. Default relationships based on recent and ongoing laboratory tests for performance at high outdoor temperatures will be included. Additional inputs (such as EER95 and/or EER and capacity at 80 F) that would better account for the characteristics of individual systems may be included. Special accommodations will be made to give fair treatment to ground source and possibly also evaporatively cooled compressors.
2. Heat Pump Model. The capacity and efficiency of the heat pump compressor, including the effect of outdoor temperature, will be accounted for. Backup strip heat will be assumed to meet the load if the compressor capacity is inadequate.
3. Other Heating. The efficiency of furnaces and other heating systems is very insensitive to hourly temperatures and part load conditions. The hourly energy use of these systems will be calculated using seasonal efficiency factors applied hourly.
4. Distribution Efficiency. For ducts in attics, a new hourly distribution efficiency multiplier will provide variation in response to the combined effect of outdoor temperature and solar radiation. This model, produced as part of the TDV project, will preserve the overall ACM seasonal distribution efficiencies, but give realistic effects for the on peak performance of distribution systems.
5. Simple Latent Model. A simple latent load model that estimates the additional load due to latent internal gains and infiltration will be included.
6. Compressor Sizing. If the proposal to implement sizing rules and requirements is carried forward, the calculated compressor size would be used in the hourly HVAC system calculations. If sizing is not implemented in the *Standards*, a default size, intended to represent the average relationship of compressor size to actual load, will be implemented. Heat pump compressor size will default to the size calculated for the air conditioner. Optional input for the size of the heat pump compressor will be considered.

Benefits

The primary benefit of these changes will be to allow the correct tradeoffs for measures that have large effects on peak electricity use and demand. These tradeoffs are required for the accurate calculations of TDV energy use. These changes will increase the compliance value of design choices that have large on peak energy use effects.

Environmental Impact

These changes will have a positive environmental impact, as builders choose measures that reduce on peak consumption, thereby reducing demand for peak powerplants, which are significantly less efficient and more polluting than baseload plants.

Type of Change

The change would modify the calculation procedures or assumptions used in making performance calculations. This change would not add a compliance option or a new requirement, but would affect the way that tradeoffs are made. This change would require extensive modifications to the Residential ACM Manual to describe the new models and their inputs, and to define or revise the tests.

Measure Availability and Cost
N/A

Useful Life, Persistence and Maintenance
N/A

Performance Verification
Default hourly performance can be assumed with little additional compliance verification beyond what is currently required. The compressor capacity of a heat pump system is an important variable that will probably need to be verified in the field. If additional performance characteristic inputs are allowed, additional field verification will be required. If EER is allowed as a compliance alternative, third party field verification of the EER used for compliance will be required.

Cost Effectiveness
N/A

Analysis Tools
N/A

Relationship to Other Measures
The implementation of TDV energy accounting makes this change very important.

Bibliography and Other Research
DOE2 Engineers Manual (2.1A). NTIS Order Number DE-830-04575.